UNIT 1: INTRODUCTION TO COMPUTER GRAPHICS

UNIT STRUCTURE

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1.1 LEARNING OBJECTIVES

After going through this unit, you will be able to:

- Describe about the computer graphics.
- Classify the application of computer graphics
- Explain about graphical user interface.
- Identify Input/ output devices used in computer graphics.

1.2 INTRODUCTION

This is the first Unit of this block. In this unit we will discus about the concept computer graphics. In the era of digital science, computer graphics becomes an efficient tool for producing pictures, motion pictures, animations, and multimedia. Nowadays, in each field, the use of computer graphics has been seen and there is no area which is left untouched by the use of graphics. Computer graphics are used in diverse areas such as science, medical, engineering, business, medicine, art, government, industry, entertainment, advertising, education and training, simulation, graph representation, printing, etc. Simulation of different experimental environments, training environments, and adventures environment are the most useful and popular use of computer graphics. An electronic circuit can be designed and developed using a simulator and can be tested in the simulation environment. After achieving success, one can move on to experiment with the real equipments. Similarly, experiments in a chemical laboratory can be implemented through simulation and it saves lots of raw materials and equipments from being damaged. Smart classes are now the most popular mode of teaching at the school level. The use of Information and Communication Technology (ICT) are increasing at all level of teacher education and the learning process. Simulation of car driving, airplane pilot training, automation, GPS tracking system, e-business, biology, different print media, and lots more are the broad application of computer graphics. There are hardly a few elements of our lives today that are not influenced by computer graphics. In the next unit we will discuss about graphic systems

1.3 DEFINITION OF COMPUTER GRAPHICS

Computer graphics is primarily concerned with image generation, with applications ranging from entertainment to scientific visualization.Computer graphics can be defined as a rendering tool for the creation and manipulation of images. Thus, computer graphics is defined

as the use of computer as a rendering tool for the development and manipulation of images. Computer graphics is the art of drawing pictures or images with the help of programming.It involves data processing, creation, and computation. Any sketch, drawing, unique artwork, or other material created with the use of a computer to pictorially describe an object or a process or transmit the information as a complement to or replacement of written descriptions is referred to as computer graphics. The base of each drawing made by computer graphics is some mathematical expression or a mathematical model. Commonly the computer graphics system represents 3-dimensional objects in a 2-dimensional viewport. To view or to project a 3-dimensional object into a 2-dimensional viewing window, lots of mathematical computation steps are required including coordinate geometry, trigonometry, and the concepts of the Bayesian Curve.

1.4 HISTORY OF COMPUTER GRAPHICS

In the year 1950, BenLaposky used an electronic machine to create an image of an Oscilloscope. It was considered the first graphics made by a human using an electronic machine they attempted to display two real-time video streams with the whirlwind computer at MIT in 1951. The term "Computer graphics" was coined by William Fetter to produce new design techniques in the year 1960. If anyone wanted to make computer graphics back in the day, they had to design and write program statements that dealt directly with the graphics hardware. Many "graphics libraries" were established to remedy this problem, but most of them were designed for specific operating systems and could not be easily converted to different operating systems or hardware. In 1961, the first video game "Space War" was launched by Steve Russel. Evan Sutherland built the first computer graphics design system as part of his Ph.D. thesis at MIT in 1963. Jack Bresenham proposed a line drawing algorithm in the year 1965. In the year 1969, The Bell Lab designed a pixel with three bits for the first time. In the early days of 1970, raster scan display devices came into the picture. PHIGS was an attempt by the ISO (International Organization for Standardization)

to produce a standard computer graphics library in the 1980s. 1974, Edwin Catmuff developed the texture mapping and the Z-Buffer Hidden-Surface algorithm. Since the development of VGA and SVGA in the 1990s, personal computers could show photo-realistic images and videos with ease. Silicon Graphics was the leading computer graphics firm in the late 1980s and early 1990s. As an alternative to PHIGS, Silicon Graphics released their graphics library (GL) as an "open" standard named OpenGL in 1992. OpenGL is still the only real-time 3D graphics standard that works on a variety of Operating Systems. The computer graphics devices required a 3D graphics solution, andas a result, OpenGL ES (Embedded Subset) was created by Silicon Graphics in the year 1993 and it evolves continuously from version 1.0 to version 3.2."WebGL (Web Graphics Library)" is a JavaScript API that allows any compatible web browser to render interactive 3D computer graphics and 2D graphics without the use of plug-ins.WebGL is integrated into all of the browsers that follow web standards, allowing GPU-accelerated physics, image processing, and effects to be used as part of the web page canvas. In 1993, Steven Spielberg made the fiction film "Jurassic Park" using computer graphics.

1.5 APPLICATION OF COMPUTER GRAPHICS

In computer graphics, an image or a picture consists of pixels. Pixel is the tiniest element of a picture. All the information regarding a pixel is stored in a frame buffer using 24-bit. It is said that a pixel is worth a thousand words. Nowadays graphics are necessary everywhere to help people understand things, thoughts, and ideas.Almost every aspect of our lives benefits from computer graphics. This section covers some of the most prominent computer graphics applications.

1.5.1 Computer-Aided Design

Mostly computer graphics are used in the design process such as engineering, and architectural design. Buildings, airplanes, spacecraft, textiles, watercraft, automobiles, and many other areas

benefit from computer-aided design. The software package CAD is typically used to design images with the features of a multi-window environment. Circuits related to network architecture, water supply, or any other utilities can be drawn with the repeated placement of some common graphical shapes. Standard shapes for communication networks, electrical circuits, water supply, and logic



Figure 1: Architectural design using CAD package (Source: Internet)

often provided by graphics packages. Instead of these, personalized or customized symbols are also useful in these packages. The graphics systems provide an automatic connection between the designed elements through which the designers can easily generate the required output picture. In a CAD application, animation can be used to get the feel of real-time wireframe displays on a video monitor. Wireframe displays allow a designer to view the interior designof an object and also the interior and exterior motions made by the object or the object's components. It is also possible to observe the behaviour of different inner components of a vehicle



Figure 1: Automobile and Mechanical Engineering design using CAD package (Source: Internet)

Figure 1 and 2 depict some of the application of computer graphics in the architectural design of a car and machinery components used

in mechanical engineering. After completion of the object design, a realistic view of the object can be obtained by applying surface rendering. Surface rendering displays the overall appearance of the final project. Using unique light effects and backgrounds, these realistic displays are utilized in product presentations and advertising automobiles and other vehicles.Graphical design can be utilized in the production of mechanical parts by defining how the surfaces of an object will be created with machine tools during fabrication.Some numerically enhanced tools can be used to create the machine parts according to this layout. Building architects used the graphics tools to design the blueprint of a building, flour-plane, positions of doors, windows, passage, electric equipment, furniture, different safety measures, etc. before construction. The birds-eye



Figure 1: Depicts two architectures of buildings using CAD (Source: Internet)

view of the building can be designed to look at the overall structure or the appearance of the building from the top that is from the sky. Electrical and other wiring design also can be built through computer graphics. Figure 3 shows some architectural designs of buildings drawn using graphics applications.

1.5.2 Presentation Graphics

Presentation is one of the most important parts of our daily work. To present a report on any survey, financial report, scientific, economic mathematical, statistical, research data, managerial report, consumer information bulletin, health, transportation, population, educational, the launch of a new product, new design

of a car, building, etc. we can use computer graphics. Nowadays, the most common application of computer graphics is presentation. During teaching, the use of a projector to present study materials in front of the students is a common tool. The presentation may contain text files in different formats, images, videos, audio files, animation, etc. The summary of a research or survey can be presented through some mathematical data, pie-chart, bar diagrams, line graphs, and many more ways.

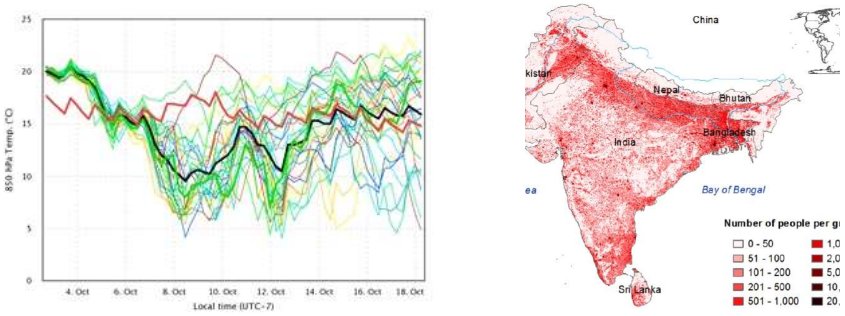


Figure 1: Depicts a weather report and geographical population density of India (Source: Internet)

1.5.3 Computer Art

Computer graphics are widely used in fine art and commercial art applications. Artists use different graphical tools to create their digital canvas such as special purpose hardware, Lumena, PixelPaint, SuperPaint, multimedia packages, CAD packages, animation packages, etc. With the help of such applications, artists can specify shapes and colours for their imaginations, and also specify motion on it.

Other computer technologies are used by fine art artists to create their images.3-D



Figure 1: Drawing of some pictures using graphics tools (Source: Internet)

modeling software, texture mapping, drawing applications, and CAD software are just a few of the technologies used by fine art artists. Modern graphics tools can use to generate electronic designs such as commercial art for logos, page layouts, advertisements, etc. Animation is frequently used in advertising or the creation of cartoon series for kids. "Tom and Jerry", "ChotaBhim", and "Doremon" are some popular animated cartoon series telecast on television. Morphing is another common application of computer graphics, where one object is transformed into another.

1.5.4 Entertainment

Computer graphics are commonly employed in the production of films, music videos, and television shows.Some scenes are fully made out of visuals of graphics only, while others combine actors with graphical scenes. "Tom and Jerry" is a good example of a motion picture (Popular Television Show) that is entirely used the graphics method. "Jurassic Park", "Spiderman", "Harry Potter", etc. are examples of motion pictures where graphics scenes are made with actors. Similarly, graphics scenes are used in music videos also.



Figure 1: Images from animated motion pictures (Source: Internet)

1.5.5 Education And Training

In the 21st century, education without computer graphics is almost nill. Students can learn most of the things or concepts through animation or graphical representation of any scientific phenomenon, economic analysis and biological events over the internet. The concept of smart classes is widely used in school-level learning. Through smartclasses, students can perform their laboratory

activities for physics, chemistry, biology, etc., and experience different scientific phenomena virtually. That is without going to a physical lab, they can learn from this virtual platform.



Figure 7: Simulation of a Pilot training (Source Internet)



Figure 8: Simulation of Ship-Captain Training (Source: Internet)



Figure 9: Simulation of automobile opeator Training (Source: Internet)



Figure 10: Simulation of Solar system (Source: Internet)

This method helps the students a lot because for all students of a class maybe, all the laboratory experiments are not possible to do physically or it is not possible to experience all the scientific phenomena in a classroom environment. For example how the earth revolves around the Sun or how the other planets are revolving around the Sun, how a nuclear reactor works, etc. can be present through animation. The visual scenes make the classroom environment very easy and comfortable for students. Graphical tool simulators are successfully used in different training such as training of ship captain, training for a pilot, air-traffic control, heavy equipment operators, automobile driving, etc. In a normal classroom teaching, teachers used a projector to present their slides containing different graphics or multimedia. Visualization makes learning very comfortable and fruitful. Following figures 7, 8, 9, and 10 show the simulation of the different training environments.

1.5.6 Visualization

To identify and analyze the pattern of the behaviour of data from the different fields such as business, medical, banking, etc. graphics methods are used. Nowadays supercomputers are used to process millions of data for classification based on some common behaviour. During the process, it is very difficult to observe the data pattern until and unless it represents through some diagram. The representation image may be a graph, bar diagram, pie diagram, or any other standard form. Visualization of data makes the analysis much easier and more effective. The process of producing a graphical representation of engineering, scientific, business, economics, medical, and statistical survey data is referred to as scientific visualization. The data may be 2-dimensional or 3-dimensional.



Figure 11: Illustrates a smart classroom and Simulation of high fidelity space craft modeling (Source: Internet)

The data can be scalar or vector data, any high-order tensor, or any combination of these data types.Contour plots, graphs and charts, surface renderings, and representations of volume interiors are some of the other techniques available.Image processing techniques are also integrated with computer graphics to create a variety of data visualizations, and image processing using machine learning tool enhances the process much more. E-Commerce is a trending way to increase business. To visualize the customer behaviour, the pattern of a product sales, customers interest, advertising of the new product, tracking the product delivery, etc. computer graphics are used widely and effectively. Other areas like airflow over the

surface of a spacecraft, mathematical modeling, fluid density measures through colour code, crack propagation in metals, modeling of protein, DNA, stereoscopic viewing of molecular structure, air pollution study, analysis of bowling or other activities in cricket, regeneration of different actions in different games like football, tennis ball, badminton, golf, etc., can be visualized through computer graphics attractively and effectively.



Figure 13: Structure of DNA (Source: Internet)

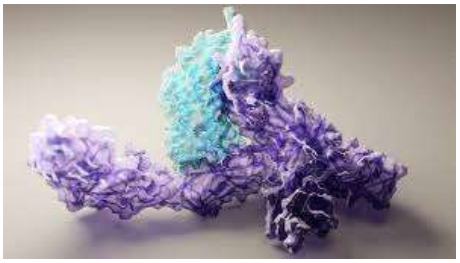


Figure 14: Structure of Protein (Source: Internet)

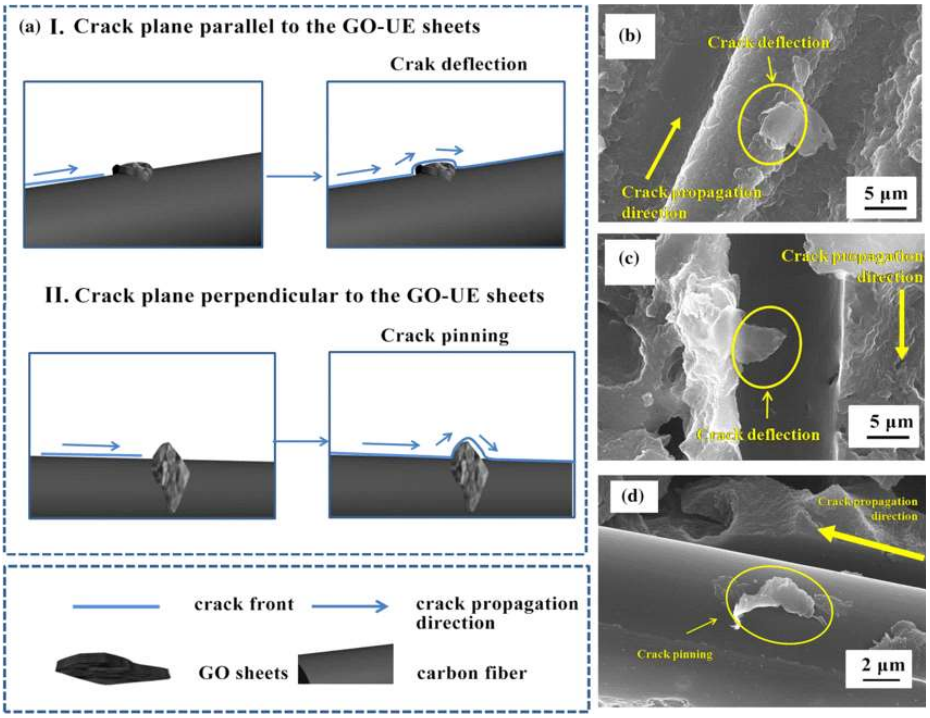


Figure 15: Illustrates Crack propagation in Metal (Source: Internet)

1.5.7 Image Processing

Image processing can be defined as a set of techniques that are used to modify or manipulate existing image definitions, whereas

computer graphics deal with image creation. Image processing can be used in improving picture quality and for the perception of visual information in the field of Artificial Intelligence. Image processing has a wide range of applications. In the field of medical science, image processing is used to analyze different types of pictures of human body parts or organs. Diagnosis of some particular diseases can be identified through image processing automatically, that is without any intervention of doctors or any experts. In the field of agriculture image processing is used to detect leaf diseases, stem diseases, bacterial infection, and soil deficiencies, also to measure PH value, nutrition amount, NPK content, and soil moisture. Proper detection and measurement of different parameters related to plant growth and fruiting can lead to healthy and beneficial farming. Nowadays through the mobile application, farmers can take a photograph of a leaf or stem and can detect the deficiencies or diseases immediately. For the wide application of image processing, drone technology is used to take photographs of gardens with big areas. Using image processing, AMAZON opened a shopping mall for customers without any salesman. Customers can pick products from stacks and add them to their carts, immediately the product details including price will reflect on the customer's mobile screen. Return of product from cart to the stack will remove the item from the list also. A set of large numbers of hidden cameras are used to detect and identify the product details with image processing techniques. Image processing is successfully used in bar code scanners, face recognition, fingerprint identification, access vehicle details from number plates, etc.



Figure 16: Depicts face recognition and leaf disease detection using image processing(Source: Internet)



Figure 17: Depicts Soil testing using image processing(Source: Internet)



Figure18: Plant health checking by a drone using image processing (Source: Internet)

1.5.8 Graphical User Interface

A graphical user interface (GUI) provides a platform to interact with the software package.The window manager is a major component of the graphical user interface that allows a user to show several windows. With graphical or non-graphical displays, each window may have a different process. To interact with a particular window, a click event is necessary to select the specific window. A good GUI should have a menu with a link for different windows or processes or different parameter values. Nowadays almost all the software packages come with GUI.



CHECK YOUR PROGRESS

Q 1: Fill in the Blanks

a) Computer graphics is primarily concerned with ……

b) In the year 1950, ……. used an electronic machine to create an image of an Oscilloscope.

c) The techniques that are used to modify or manipulate existing image definitions is known as ……

d) GUI stands for ……

1.6 INPUT DEVICES

For graphics workstations different input devices are available. Some common input devices are keyboard, mouse, joystick, image scanner, etc. some specified input devices are digitizers, trackballs, spaceballs, datagloves, touch panels, and voice systems.

A keyboard is a common input device used to provide text as input. Through the keyboard, users can input strings of characters, alphanumeric characters, numbers, operators, and different symbols. Functional keys and cursor control keys are used for performing specified predefined functions.



Figure 19: Input devices keyboard, mouse, and trackball (Source Internet)



Figure 20: Figure 19: Input devices Joystick, Image scanner, and data gloves (Source Internet)

Mouse is an input device used for pointing a point on the display screen, performing click events, and scrolling up and down a document. We can also use the mouse to zoom in and out of an image by scrolling up and down. Mouse's click event can be used to select text area, perform copy and paste, draw pictures, select menu items from GUI, etc.

Trackball and space-ball are input devices that can be rotated by the fingers or palm of the user. The rotation of the ball changes the cursor position on the screen. The trackball is a two-dimensional positioning device, whereas the space-ball provides six degrees of freedom. Spaceballs are used for three-dimensional positioning and selection operations in virtual reality systems, modeling, animation, CAD and other applications.

A joystick is a small vertical lever attached to a base that is used to move the cursor around on the screen. Some joysticks use the movement of the lever to determine position, while others use pressure on the stick.Isometric joysticks are another term for pressure-sensitive joysticks.A strain gauge measures the pressure on the joystick, which is then transformed into cursor movement in the desired direction.

Data gloves that can be used to grasp a virtual object. Hand and finger motions are detected by several sensors built into the glove. To provide information on the position and orientation of the hand, electromagnetic coupling between sending and receiving antennas is used. The glove's input can be utilized to position or manipulate virtual objects. On a video monitor, a two-dimensional projection of the scene can be viewed, or a three-dimensional projection can be viewed with a headset.

Image scanners are used to collect information regarding drawings, graphs, colour, black and white photos, text, etc. and be stored for further processing. The image data then can be used to perform transformation operations such as translation, rotation, reflection, cropping etc and fit to a required window.

Light Pens are pen or pencil size electronic devices, which can detect position on a display screen through the detection of light coming from a phosphor-coated screen. The light pens are sensitive enough to detect the light emitted from the phosphor-coated screen and detect the position. Nowadays, light pens are not used as it has lots of disadvantages compared to other input devices.

1.7 OUTPUT DEVICES

Images can have different formats. The quality of a picture depends on the size of dots, and the number of dots per inch. A printer is a hard copy output device that produces outputs either applying impact or nonimpact methods. Impact printers use an inked ribbon to print characters. A nonimpact printer may use the laser technique, ink-jet sprays, electrostatic methods, and electrothermal methods to get images. In a laser device,a laser beam causes a charge distribution on a revolving disc coated with a photoelectric material such as Selenium. The inkjet printer produces output by squirting ink in horizontal rows on a roll of paper wrapped around a drum.



Figure 21: Inkjet printer



Figure 22: Laser printer



Figure 23: Electrostatic printer

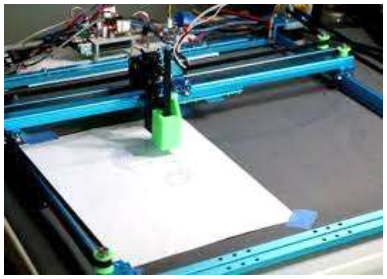


Figure 24: Plotter



1.8 LET US SUM UP

- In the era of digital science, computer graphics becomes an efficient tool for producing pictures, motion pictures, animations, and multimedia.
- An electronic circuit can be designed and developed using a simulator
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- Computer graphics can be defined as a rendering tool for the creation and manipulation of images.
- Computer graphics is the art of drawing pictures or images with the help of programming.
- Any sketch, drawing, unique artwork, or other material created with the use of a computer to pictorially describe an object or a process or transmit the information as a complement to or replacement of written descriptions is referred to as computer graphics.
- In the year 1950, BenLaposky used an electronic machine to create an image of an Oscilloscope.
- In 1961, the first video game "Space War" was launched by Steve Russel.
- PHIGS was an attempt by the ISO (International Organization for Standardization) to produce a standard computer graphics library in the 1980s.

- In computer graphics, an image or a picture consists of pixels.
- Mostly computer graphics are used in the design process such as engineering, and architectural design. Buildings, airplanes, spacecraft, textiles, watercraft, automobiles, and many other areas benefit from computer-aided design.
- Circuits related to network architecture, water supply, or any other utilities can be drawn with the repeated placement of some common graphical shapes.
- The graphics systems provide an automatic connection between the designed elements through which the designers can easily generate the required output picture.
- To identify and analyze the pattern of behaviour of data from the different fields such as business, medical, banking, etc. graphics methods are used.
- To visualize the customer behaviour, the pattern of a product sales, customers interest, advertising of the new product, tracking the product delivery, etc. computer graphics are used widely and effectively.



1.9 FURTHER READINGS

1) Book Name: COMPUTER GRAPHICS C Version, Authors: Donald D. Hearn, M. Pauline Baker, Publisher: PEARSON.
2) Book Name: Computer Graphics (Special Indian Edition), Authors: Zhigang Xiang, Publisher: Amer Media Intl - McGraw Hill audio



1.10 ANSWWERES TO CHECK YOUR PROGRESS

Ans to Q No 1:

a) image generation b) BenLaposky c) image processing d) graphical user interface.



1.11 MODEL QUESTIONS

Short Questions (Answer each question in around 150 words).

Q 1: Define computer graphics.

Q 2: Explain interactive and non-interactive computer graphics.

Q 3: List and explain the applications of computer graphics.

Q 4: State the importance of image processing.

Q 5: Differentiate between image processing and computer graphics.

Q 6: List some standard input and output device hardware used by computer graphics.

Q 7: Write in detail about digitizers.

Q 8: Write a short note on hard copy technologies.

Q 9: Explain the history of computer graphics.

Q 10: Differentiate between impact and nonimpact hard copy devices.

Q 11: Explain the use of data gloves and plotters in computer graphics.

Q 12: Describe the working principle of a joystick.

Q 13: Define the term simulator. Explain the role of a simulator in the field of education.

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